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THE BLOOD**

BY PROFESSOR D. FRASER HARRIS, M.D., C.M., D.Sc., F.R.S.E.

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THE discoverer of the circulation of the blood was a London doctor called William Harvey.

The discovery of the circulation of the blood is the foundation of modern medicine; it was epoch-making, for it made possible that marvellous epoch in which we have seen the laws of living matter discovered and the actual, physical causes of the most mysterious diseases revealed. Harvey closed the dark ages of the science of the living; physiologically he "allured to *brighter* worlds, and led the way." Until it could be known that the blood, the same blood, moved round and round the body under the force of the propulsion of the heart, and that it traversed heart and lungs and all body-vessels in its closed circuit, there could be no physiology, no pathology, no therapeutics, no rational medicine: no such procedure as transfusion of blood. To understand what it was that Harvey discovered, we need to know what was believed as regards the movement of the blood before his time.

The oldest idea of all was that only the veins contain blood, the arteries air. Galen had corrected this latter mistake by tying a cord above and one below a length of artery and cutting out the piece above and below the ligatures; blood, of course, and not air was found inside. It was thought that blood went up and down the veins like the ebb and flow of a tide, that "crude" blood was made in the liver and taken to the heart to be purified. The heat supposed to be produced in this process was believed to make it necessary to cool the heart by drawing in air in the act of breathing, and this was regarded as the function of respiration even as late as the time of Haller, that is, the middle of the eighteenth century. The pulse or opening up of the arteries was regarded as an active thing on their part, blood not being forced into them by the heart but drawn into them by their own suction like a bellows draws in air. But Harvey said the heart is the pump, and the arteries are filled by its forcing its blood into them.

Harvey advanced not one or two but more like a dozen proofs of the circulation. His contention is—the blood in the arteries moves towards the tissues, thence towards the veins, it is collected in the right auricle of the heart, whence it flows to the right ventricle, this on contracting drives it through the lungs, whence it flows to the left auricle, passes to left ventricle and so is ready to be sent to the body again. Galen had

said that almost all the blood passed from the right to the left side of the heart across the septum of the heart, but Harvey, maintaining that the septum was not porous, proved that *all* the blood, not merely some of it, went round by the lungs.

Of course, this pulmonary or "lesser" circulation *was* taught before his time, notably by Servetus and M. R. Columbus; but it was Harvey who first showed that the valves of the heart and the valves of the veins absolutely prevent any other direction of flow except from the veins to the right heart and thence *via* the lungs to the left heart. This doctrine of the porosity of the septum died hard, for we find Harvey, towards the close of his life, attempting to convince an objector—Professor Riolanus—that if only he will pour water into the right heart and tie all vessels to and from the lungs, not one drop will get into the left ventricle.

No one before Harvey had fully understood the venous valves. His own professor at Padua—Fabricius—had talked a great deal of nonsense about them in a treatise entirely devoted to them. Harvey said that they were not primarily for supporting columns of blood, but for preventing any back-flow towards the periphery, seeing that they were present in the veins of the head in which the blood (under gravity) flowed past them with the greatest ease: here, since they *opened* towards the heart, they could not support any column of blood.

In Chapter II. of his great book—the "*De Motu*"—his chief point is, "the charge of blood is expelled by force," that is, the heart is dynamic for the circulation, a point by no means admitted before his time, for M. R. Columbus denied the heart to be even muscular. Harvey is absolutely clear on this point; he writes:

It is in virtue of one and the same cause that all arteries of the body pulsate, namely, the contraction of the left ventricle.

Again in Chapter V. he writes:

The one action of the heart is the transmission of blood and its distribution by means of the arteries to the very extremities of the body.

In Chapter VI. he gives a remarkably good account of the circulation through the fetal heart, that is, before lungs are developed; it is surprisingly accurate to have been done three hundred years ago. In Chapter VII. he returns to the circulation through the lungs and clearly arrives by induction at the existence of capillaries; the word of course he does not use, he calls them "porosities of the flesh," but he understands perfectly that arteries do not become veins without undergoing some complete change in structure and nature. He says if arteries became veins, there would be a pulse in the veins, marvellously good physiology for 1628!

Owing to his having no microscope sufficiently powerful, Harvey could not *see* the capillaries even in those transparent animals which he

scrutinized with his simple lens, but he inferred the existence of capillaries without ever seeing them. There are at the Royal College of Physicians in London three large boards on which he has dissected out the blood-vessels of the human body to the extreme limits which his scalpel would allow him. There they are to this day, a testimony to his eagerness to find those vessels in which the arteries ended. But it was not to be: I sometimes call these "*tabulæ Harveianæ*," his "sorrow's crown of sorrows," for his finest dissection could not reach the capillaries. Three years after his death, in 1660, the great Italian naturalist, Marcello Malpighi, at Bologna, was the first of all men to see the living capillaries in the lung of the frog; he saw the blood coursing through them exactly as Harvey had predicted. Systemic capillaries were first seen in 1688 by Anthony van Leeuwenhoek, the Dutchman, at Delft.

Chapter VIII. contains the *epoch-making metaphor*, "motion as it were in a circle," "motion of the blood we may be allowed to call circular." Chapter IX. contains the argument from quantity, one of the subtlest in the whole book. It is a matter of very simple calculation to show that in an hour or two the heart will eject far more blood than the body possesses unless the blood comes back again to the heart: Harvey showed that the body of a sheep does not contain much more than about four pounds of blood, but that in an hour quite seven pounds of blood have passed through the heart. Now the heart can not deal with more blood than the body possesses, therefore blood is continually returning to the heart. Harvey, believing that the blood carried the nourishment to all parts, applied this view to an actual case of pulsating tumor which he had to treat: he tied the artery so tight as to stop the blood-flow to the tumor which shortly dried up from lack of nourishment. He had the full courage of his convictions; he applied his scientific knowledge to a surgical case for the relief of a suffering man. Chapter XVI. has the most interesting application of all; the argument based on the general or systemic effects of local absorption. Harvey points out that poisoned wounds, what we should call local infection, can poison the whole body; certainly this could not be so unless there was a carrying of the poison round through all the body, but that is just another expression for circulation. Were it not for the circulation, food absorbed where it is digested could never be distributed over the whole body: the circulation accounts equally for the universal distribution of food, drugs and poisons. Not until this was understood could there be a rational basis for physiology or the healing art; Harvey divides the empirical from the rational, for ever. In this way we may say emphatically that the discovery of the circulation was epoch-making, it brought in the era of experiment in biology, for Harvey experimented; had to do so in order to see nature at work; he tied this vessel and that, he looked into the body for himself; he was done with what Aristotle or Galen had said, done with library or arm-chair physiology.

I sought to discover the motions and uses of the heart from actual inspection and not from the writings of others; at length, and by using greater and daily diligence and investigation, making frequent inspection of many and various animals, and collating numerous observations, I thought I had attained to the truth, etc.

He says he has gone to work, "in order that what is false may be set right by dissection, multiplied experience and accurate observation." No short cuts, no shirking of trouble: no royal road to physiology. He goes on:

Doctrine once sown strikes deep its root, and respect for antiquity influences all men. Still "the die is cast," and my trust is in my love of truth and in the candor of cultivated minds. Harvey was a gentleman.

Harvey demonstrated to any one who wished to see; to Hoffman at Nuremberg, to Vesling at Padua, to King Charles I., to whom he showed much: the king went with his physician to see a patient, a son of a Lord Montgomery, whose heart was congenitally exposed (ectopia cordis). Harvey dedicated his "De Motu" to the king.

Harvey did not apparently think of injecting the vascular system with some kind of colored liquid, as was done shortly after his death by several observers, notably by Ruysch of Amsterdam. But even had he so filled the vessels and therefore the capillaries, he could not, in the absence of all histological technique, have seen them in the opaque tissues. Harvey made the capillaries a logical necessity, Malpighi made them a histological certainty. But Harvey did much more than discover the mechanism of the circulation. He attempted with all the assiduity of his nature to discover the mechanism of reproduction and the course of development of the embryo.

Inexorably hampered by having no microscope wherewith to explore the ultraviolet, Harvey nevertheless reached conclusions which have stood the test of time. He insisted that that small white speck on the surface of the yolk (the cicatricula) was the precursor of the chick, that the whole future animal came from a fertilized germ, and that every living being came from an egg (ovum). Such were by no means the views held by the majority of naturalists in his day; he was once more ahead of his time. Not until 1827, by von Baer, was the full truth of these things substantiated.

Harvey when Warden of Merton College, Oxford, where he was for two years when Oxford held out for Charles, associated himself with a Dr. Bathurst in experiments on development. Dr. Bathurst had hens laying eggs in his rooms in college, so that the embryo chick might be studied at any stage of its evolution.

Harvey furthermore wrote a treatise on respiration and one on insects; these, along with notes of post-mortem examinations (pathological anatomy), were all destroyed when his rooms in Whitehall were ransacked by the soldiers of the Parliament in 1642, an indelible stain

on the records of that assembly. With Newton & Carlyle, Harvey is in distinguished company as regards the destruction of manuscripts.

William Harvey, the eldest of the nine children (seven sons and two daughters) of Thomas Harvey and Joan Halke, was born at Folkestone on the south coast of England on April 1, 1578. Queen Elizabeth was at this time on the throne. His father was a prosperous yeoman, and in 1600 mayor of Folkestone. The Harvey family had not been a medical one; William was the only son who did not go into business.

There still exists a memorial brass to Harvey's mother in the parish church (St. Mary's) at Folkestone: she was only fifty years old at the time of her death. From a nephew, Daniel Harvey, are descended the noble families of Winchelsea and Aylesford. One of William's brothers was called Eliab; he became a Turkey merchant in London and managed his brother's affairs; for, like many geniuses, William was "constitutionally incapable of making a bargain." Eliab managed his money matters so well that William was always quite comfortably off. One of Eliab's descendants was Sir Eliab Harvey, G.C.B., who commanded the *Temeraire* at the battle of Trafalgar.

In 1588, when ten years old, Harvey was sent to the King's School at Canterbury, where he remained five years. It is thus perfectly possible that from his home on the English Channel he may have witnessed some of the engagements which led to the overthrow of the Spanish Armada, which occurred in August, 1588. When sixteen years old he entered Gonville and Caius College, Cambridge, on May 31, 1593. The entry is still to be seen in the records of that notable seat of medical learning founded by John Keys, the man who introduced into England from Italy the academic study of anatomy and the dissection of the human body as an essential means thereto. Harvey took his B.A. degree in 1597. As Harvey's father was a man of means, he could afford to send his son to study at the great University of Padua in north Italy, at that time and for long afterwards the most famous of the European schools of medicine. Harvey entered the University of Padua in 1598, and left it as doctor of medicine in 1602. The original of his doctor's diploma is in a glass case in the library of the Royal College of Physicians in London. I have had this priceless document in my hand; it is printed in the Latin language on vellum; the margins have been beautifully decorated by some artist in colors which are still perfectly fresh.

As an undergraduate, Harvey seems to have been a representative student, for he was elected three years in succession conciliaris of the English nation, as it was called. The students at Padua were divided into nations for the purpose of voting for their rector, a system, for instance, only just abolished in the University of St. Andrews, Scot-

land. Padua recognized the English and Scottish nations as late as 1738. The MSS. lists of students for the sessions 1600-01 and 1601-02 begin with a "Gulielmus. Arveius. Anglus." These representatives of voting nations had the privilege of having their "stemmata" painted up somewhere within the university precincts. After a most laborious search, Harvey's stemma was found covered with whitewash on the concavity of the roof of the lower court-yard of the university. The master and fellows of Caius College have had it restored in its original colors; and very fine it is with a red ground, a white sleeve and green serpents; above it is the one word, "Anglica," and below it the three words, "Gulielmus. Harveus. Anglus." Precious words, for this is undoubtedly *our* William Harvey, then a youth of twenty-three years, who a little later was to reveal something which was to place his name beside the greatest names in the history of human discovery. He was soon to become an epoch-maker. But as a doctor of medicine later on he would be entitled also to have his coat-of-arms emblazoned somewhere in his alma mater. In March, 1893, after a most tedious search, the rector of that time discovered the shield with Harvey's arms, but so damaged that the inscription which accompanied it was lost for ever.

A few details are preserved to us of the social conditions at Padua in Harvey's time, and they show us a very miserable state of affairs. Food was scanty and bad, there was no glass in the windows, which were of linen; artificial light was extremely costly, and there were no public entertainments. The professor of anatomy was the venerable Hieronymus Fabricius ab Aquapendente, surgeon, anatomist and historian of medicine, a great favorite with the Venetian senate, who were the patrons of the chairs at Padua. The little theater in which he lectured at nine each morning from October to August still exists. It is of oval form, lined with oak, with steep-pitched, narrow platforms (instead of seats) with low rails to lean over to watch the dissection. There is a small cupola in the roof. It was not without some emotion that the present writer stood one September morning on the very spot where there came to Harvey the illuminating thought about the venous valves.

Harvey returned to Cambridge in 1602, when he at once took the M.D. degree at his English alma mater. By 1604 he had entered upon medical practise in London in St. Martin's parish; and on November 24 he was married in St. Sepulchre's church, Newgate, to Elizabeth Brown, daughter of Dr. Lancelot Brown, who had been one of the physicians to Queen Elizabeth. It was the bells of this same church that for many years were tolled on the morning of an execution in the prison of Newgate over the way. The Harveys had no children; his wife predeceased her husband.

In June, 1607, Harvey was elected a fellow of the College of Physicians, not yet Royal; and by 1609 he had been appointed one of the physicians to St. Bartholomew's Hospital, a charity justly proud to remember the fact. In 1615 he was made Lumleian lecturer at the College of Physicians, a post he held until 1656. In 1618 Harvey was appointed physician to King James I. and VI., and in 1631, physician-in-ordinary to King Charles I.

Lecture notes of Harvey's dated 1616, now in the British Museum, show that by that time he was teaching the doctrine of the circulation, but it was not till 1628 that he published with William Fitzer at Frankfort-on-the-Main a quarto entitled "*Exercitatio anatomica de motu cordis et sanguinis in animalibus*." An epoch-making essay this! and I am not forgetting either Schwann on the cell-theory or Darwin on the "*Origin of Species*." The "*De Motu*" is a good example of a great book which is not necessarily a large one; it has only 72 pages. Harvey published his book at Frankfort because of the important book-fair held there annually, so that the work might have a better chance of being rapidly taken up than if brought out in England, then vastly more isolated from the Continent than it is nowadays.

Possibly no epoch-making book had a worse reception. Previously to publishing the "*De Motu*," Harvey's practise was very large, for he was a skillful surgeon and obstetrician; but Aubrey tells us that after 1628

He fell mightily in his practise; 'twas believed by the vulgar that he was crack-brained and *all* the physicians were against him.

Harvey was quite alive to the possibility of opposition and even dislike, so truly did he know that anything new is objected to, so difficult is it to overcome mental inertia. Listen to him:

These views *as usual* pleased some more, some less; some chid and calumniated me, and laid it to me *as a crime* that I had dared to depart from the precepts and opinion of all anatomists. I tremble lest I have mankind at large for my enemies, so much doth wont and custom become a second nature.

He got what he expected, the usual treatment meted out to those who dare to upset what has been believed for a long time; people do *not* like to be disturbed physically or mentally.

From 1628 onwards, Harvey's spare time may be said to have been occupied in defending and expounding his so-called "*doctrine*" of the circulation, for both at home and abroad all the professors of anatomy were at first disbelievers. Harvey is most long-suffering towards that "*tympanitic philistine*," as Huxley called him, Riolanus of Paris. He is most courteous to him, he calls him "*a learned and skillful physician, and the Corypheus of anatomists*." Riolan was physician to Marie de Medici, mother of Louis XIII., and of Queen Henrietta Maria. Harvey met him once at Whitehall.

The great discovery had plenty of opposition everywhere, but I am

particularly sorry to have to say that the first person to write formally against Harvey was a Scotsman, a Dr. Primrose. He had been a pupil of Riolanus; he published his feeble tract in 1630. Harvey never replied to Primrose, probably because his book was sheer Galenism and because he had only just been admitted into the College of Physicians, Harvey being one of his examiners. This Dr. James Primrose was of the same family that gave rise to that of the Earls of Rosebery. A longer, but still weaker, protest was made in 1635 by one Parisanus, of Venice; Harvey did not reply to this, either; there was nothing new in it.

Caspar Hoffman of Altdorf was, in point of time, the next objector, as we gather from Harvey's letter to him dated May, 1636. Hoffman's difficulty is one very typical of the prescientific spirit, the spirit of the middle ages; it is this: Harvey has made out nature to be a clumsy and inefficient artificer in causing the blood to return again and again to the heart to be reconcocted. This objection we should now call teleological; Harvey's reply virtually is, that teleological difficulties must not prevent our drawing conclusions from facts observable in the living animal. Blood constantly pours through the heart in one direction only; if we can not explain this, that must not prevent our admitting that it does so. Harvey virtually says: you must not weight your physiology with a theological load.

The difficulty of Professor Vesling of Padua was neither frivolous nor antiquated, it was a real one: how is it possible for the blood in arteries and veins to be the same blood when it is scarlet in the one and purple in the other? This would be a difficulty to us still, if we did not know the physico-chemical reasons for the change of color. Naturally, Harvey's answer is not any explanation of the change of color; he can only emphasize the arguments of the "*De Motu*," which are so full and so convincing to those capable of appreciating the experimental method.

It can not be said that Harvey's life was destitute of incident, for his appointment as physician to Charles brought him into contact with many interesting and distinguished people, and led him into many stirring scenes. He accompanied Charles at least on one visit to Scotland, namely, that for his coronation in 1633. We know this, because there exists in the records of St. Bartholomew's Hospital a request for Harvey to absent himself, and that a substitute be allowed to act for him. Harvey was a very great deal with the king and accompanied His Majesty on his hunting expeditions, when he had opportunities of examining the bodies of deer, observations he turned to good account in his work on development ("*De generatione*").

It can not but be interesting to some of us to know that William Harvey was in Edinburgh. As personal attendant on the king, he

must have been at Holyrood and present at the banquet in Edinburgh Castle given by the Earl of Mar on June 17, 1633, in honor of the king. Charles remained two months in Scotland, from the middle of May to the middle of July, and we have a curious piece of incidental evidence that Harvey was with him all the time.

In his book on development, Harvey has left on record the appearance of the Bass rock "during the months of May and June" in a description he wrote of that island, which he visited for the purpose of studying the embryo in the eggs of the solan goose. His description of the myriads of these birds on the rock would be quite true to-day.

Harvey was at least once actually under fire in a battle of the civil war, namely, at the battle of Edgehill, where he had charge of the royal children, afterwards Charles II. and James II. Aubrey tells us that "a shot from a great gun" made them seek better shelter; we are also informed that Harvey read Fabricius on generation during the battle.

Harvey traveled a good deal on the continent of Europe; from 1631 to 1633 in Spain with the Duke of Lennox; while in 1636, in company with the Earl of Arundel, who was sent on a diplomatic mission to Vienna, he made an extensive tour which included Rome. They visited The Hague, Leyden, Cologne, Nuremberg, Lintz on the Danube, Baden, Ratisbon, Treviso and Venice. The records are still extant of the visit of the party to the English college at Rome; Lord Arundel was a Roman Catholic. To Dr. Weir Mitchell, F.R.S., of Philadelphia, we owe only this very year the publication of a number of previously unpublished letters written by Harvey on this journey to the Lords Feilding and Dorchester. They cast very interesting sidelights on men and manners; but we must not be tempted to linger over them.

At Florence Harvey and the Earl's party were entertained by that celebrated patron of learning, Ferdinand II., Grand Duke of Tuscany. At Nuremberg on this tour it seems almost certain that Harvey's portrait was painted by William van Bommel. It is the portrait in which the heart and arteries are displayed in a dissection on the right of the figure. He was fifty-eight years old at this date.

A few of Harvey's more notable patients were: King James I., the Lord Chancellor Bacon, the Earl of Arundel, Prince Maurice, brother of Prince Rupert, a son of the Viscount Montgomery, Sir William and Lady Sandys and Sir Adrian Scrope.

Of his friends in England we know the following were of the number: the aged philosopher Hobbes, of Malmesbury; the Hon. Robert Boyle; Robert Hooke, F.R.S., the natural philosopher; Dr. Argent, Sir George Ent, Aubrey the antiquary, and Selden the lawyer.

Of three of his medical pupils—Scarborough, Willis and Highmore

—two have left their names embedded in anatomical nomenclature: in the circle of Willis and the antrum of Highmore.

It was in conversation with Boyle that Harvey admitted that the idea of the circulation came to him after pondering on the way in which the valves of the veins were placed with reference to the heart. Boyle's words are:

When I asked our famous Harvey, in the only discourse I had with him, what were the things that induced him to think of a circulation of the blood, he answered me, that when he took notice that the valves, etc.

Now it is a very remarkable thing that Bacon in all his writings has not one word on the circulation, though its discovery was such an admirable example of the success of the inductive method he so laboriously recommended.

One other very great Englishman was a contemporary of Harvey, I mean the author of the plays and poems known as Shakespeare's. It has been conjectured that this very gifted person did know of the circulation and made allusion to it in his writings. Having looked into the question pretty carefully, I have come to the conclusion that this writer did not understand the circulation of the blood, although he had some acquaintance with anatomical terms and with the medicine of his day.

The champions of the Harveian "doctrine" were all foreigners, I suppose on the principle that a prophet hath no honor in his own country. The great philosopher Descartes convinced himself of the truth of Harvey's assertions by making a large number of dissections; but Descartes was not a medical man and not a teacher. Professors Sylvius of Leyden, Trullius of Rome and Bartholinus of Copenhagen were all ardent defenders of the Harveian faith. So enlightened a contemporary as Sydenham, the English Hippocrates, was not a convert. An admirable observer, he had, nevertheless, not a receptive mind; it was strong enough, but it was narrow. Alluding to Harvey and his school—the experimental one—he said:

We may know the larger organs of the body, but its minute structure will always be hidden from us. No microscope will ever show us the minute passages by which the chyle leaves the intestine or show by which the blood passes from the arteries to the veins.

This is in his "De podagra" and his "De Hydrope" published in 1683. Sydenham was a little behind the times, for twenty-three years before Malpighi had, by the despised microscope, found the capillaries by which the blood of the arteries of the lung reaches the veins of that organ, and only five years after this statement was made, namely, in 1688, Leeuwenhoek, the Dutchman, discovered the capillaries of the general vascular system. So much for prophecy in biology when it is not based on a direct study of nature!

Some of Harvey's experiences were unique; he dissected the body of one of the oldest men that ever lived, Thomas Parr. Old Parr, a native of Shropshire, died in 1635, aged 152 years; he had lived under nine British monarchs. Harvey found no physical signs of senility in the body, no lime in the costal cartilages. He suggests that the sudden change from the old man's simple fare to the rich food of Lord Arundel's establishment was the cause of death. Harvey tells us that old Parr lived on sour milk and rancid cheese; he thinks he survived in spite of this diet, the followers of Metchnikoff would tell us that he lived so long on account of it.

Another of Harvey's curious experiences was the affair of the Lancashire witches. This reveals the gross superstitions that could flourish in 1634 and engage the attention of the king, a bishop or two, a secretary of state and the Lord Privy Seal. A boy playing truant in the woods in Lancashire swore that he had been carried off by a witch, Mother Dickenson. She bore him over fields and forests till she came to a barn where seven other witches were having supper when, he said, they assumed the shapes of all sorts of animals. This rigmarole and a great deal else was actually believed. The king commanded the Earl of Manchester to order a commission of medical men, one of whom was Dr. Harvey, to empower certain midwives to examine the bodies of these women, to see whether they had any marks on them indicating anything unnatural. The examination was carried out in Dr. Harvey's presence, and, of course, nothing was found. We have no scrap of evidence to make us think that Harvey in any way shared the popular superstition as to these women; he was merely carrying out the royal commands.

In personal appearance Harvey was of short stature; "of the lowest stature" and "little Dr. Harvey" are the phrases used to describe him. At thirty-seven years old, his hair was black; his eyes small and black. He seems to have been restless, full of energy, rapid of utterance, given to gesture and to playing with the hilt of a small dagger he wore. His handwriting was exceptionally good even for that time. From all we can gather, his temper was irritable; "choleric" is the word used of him again and again. If this was so, Harvey wrote very courteously to his most tiresome opponents, as Professor Huxley has remarked. Seeing that he lived to the age of seventy-nine, and came through the fatigues that he did, he must have had a fairly good constitution.

Harvey was very fond of coffee, a beverage in his day by no means universally taken; and on his own confession he occasionally drank freely of spirituous liquors. In later life he suffered from sciatica and gout, that disease of the intellectual hierarchy. His grandniece told Dr. Heberden in 1761 that her great ancestor, in his later years, sub-

stituted sugar for salt in his food. This observation is rather interesting in the light of the modern notion that excess of common salt leads to a retention of sodium urate in the tissues; it looks as though Harvey had found this out by experience.

As regards portraits of this epoch-maker, we are fortunate in possessing more than one. I have mentioned the van Bommel, the engraving of which by Houbraken is well known. The oil painting in the upper Library Hall of the Royal College of Physicians, represents Harvey in later life. It was painted by Cornelius Jansen and survived the fire of London. There is also a head by an unknown artist in the National Portrait Gallery in London; this is the portrait reproduced in the memorial edition of the "*De Motu*" (Canterbury, 1894). In the rooms of the Royal Society in Burlington House, there hangs another head, a portrait of Harvey done by Jan de Reyn; it is undated.

My learned friend, Sir James Sawyer, M.D., of Birmingham, England, points out an interesting difference between the styles of dress in the two portraits, the Jansen and the de Reyn; in the former the collar is that of a cavalier, in the latter of a Cromwellian! Harvey lived eight years under the commonwealth; and Sir James's inference is that he altered his dress to accord better with the more solemn taste prevailing during the period of Cromwell's power.

As regards statues of Harvey, there are only two in the open air in England, as far as I know. One in stone is high up on the pediment of the building of the College of Physicians in Pall Mall where he stands between Linacre and Sydenham: the other is of bronze on a high pedestal on Folkestone Leas; there he stands looking out across the Channel away to those lands where he received his inspiration and where he was first sympathetically understood.

In connection with Harvey's religious position, we have hardly any facts to go on. Some have surmised that because he travelled with the Earl of Arundel, Harvey also must have been a Roman Catholic. I hardly think that a papist would have begun his will in the words he does

In the name of the Almighty and Eternal God. Amen! I do most humbly render my soul to Him that gave it, and to my blessed Lord and Saviour, Christ Jesus; and my body to the earth to be buried.

In any case, the prince of biologists can not be accused of irreverence, far less of atheism. Harvey was the very opposite of irreligious. Once and again in his writings he alludes to divine purposes and designs. He says when he first looked at the beating heart, its movements were so tumultuous as to be comprehended by God alone. Referring to the valves in the veins, he says they were so placed by divine purpose.

William Harvey died at Roehampton in Surrey, on the third of

June, 1657. From the only account we have of his last days, there is no question that he died of left cerebral hemorrhage, for he had aphasia and paralysis. In a death-mask made from the old bust in the church, the right eye is more closed than the left, which would agree with right-sided paresis.

He was buried on June 26 in the Harvey vault which his brother Eliab had constructed below the parish church of Hempstead only two years before. Hempstead is an ancient village seven miles southeast of Saffron Walden in Essex. The funeral was attended by the president of the College of Physicians and a deputation from the same, and by Aubrey, his biographer, who helped to place the body in the vault. Aubrey says he was "lapt in lead," and on his body in great letters his name, "Doctor William Harvey." Quite a number of the members of the Harvey family were buried in these curious mortuary cases. In 1847 the late Sir B. W. Richardson, on visiting the church, found the window of the vault broken and rain gaining access to the floor: the case containing Harvey's remains was cracked and a frog jumped out of it. Richardson rightly thought that this state of things was not as it should be. In 1878 the conditions were still worse; by aid of magnesium light and a mirror he managed to reflect some light into the case and convinced himself that some remains were there. Accordingly he obtained permission from Dean Stanley to have the shell reburied under a glass slab in the pavement of Westminster Abbey beside the grave of John Hunter, Hunter his descendant, not according to the flesh, but according to the spirit of a seeker after truth. Owing to the Dean's death, the project fell through. In 1882 the tower of the church fell through the roof, and Richardson thought the sooner that Harvey's remains were put in a place of safety the better. At the expense of the College of Physicians, a beautiful sarcophagus of white Sicilian marble was built in the north transept of the church just above the vault, and on St. Luke's Day, 1883, Richardson and seven other Fellows placed the old shell in the sarcophagus which bears this inscription.

The remains of Harvey, the discoverer of the circulation of the blood, were reverently placed in this sarcophagus in 1883 by the Royal College of Physicians of London.

On the wall of the chapel close to the tomb there is a bust above the family coat-of-arms and a Latin inscription, a translation of which I shall give here, as it is in no account of Harvey's life and because it is always interesting to know what the competent contemporary opinion of a man was. The translation I owe to the kindness of my learned friend, Professor Wallace Lindsay, M.A., LL.D., of the University of St. Andrews:

William Harvey, to whose honorable name all academies rise up out of respect, who was the first after many thousand years to discover the daily move-

ment of the blood, and so brought health to the world and immortality to himself, who was the only one to free from false philosophy the origin and generation of animals, to whom the human race owes its acquirements of knowledge, to whom Medicine owes its very existence, chief Physician and friend of their Serene Highnesses James and Charles, Monarchs of the British Isles, a diligent and highly successful Professor of Anatomy and Surgery at the College of Medicine at London; for them he built a famous Library and endowed it and enriched it with his own patrimony. Finally after triumphal exertions in observation, healing and discovery, after various statues had been erected to him at home and abroad, when he had traversed the full circle of his life, a teacher of Medicine and of medical men, he died childless on June 3 in the year of grace 1657, in the eightieth year of his age, full of years and fame.

The Royal College of Physicians, of which he had been president in 1654, benefited greatly under Harvey's will, but it had already found him a noble benefactor during his life. In 1651 he had built a library and a museum for the college at Amen Corner; and, as acknowledgment, the Fellows erected a statue of him in their hall which was destroyed in the fire of London. Harvey assigned to the college his patrimonial estate of Burmarsh in Kent, a donation which provided the salary of the librarian and keeper of the museum. He also instituted an annual oration in praise of the benefactors of the college, and provided for an honorarium to the orator and for the expenses of an annual banquet. The Harveian oration has been delivered each year since that time; it is considered one of the greatest honors that can be paid to a Fellow to appoint him Harveian orator.

Curiously enough, there is no biography of Harvey that can be called authoritative. The only contemporary account of him, for it can not be called a biography, is by his friend, John Aubrey, the antiquary, the same Aubrey who has left us *some* facts about Shakespeare. This is an unsatisfactory, slight, gossiping account written by a medical layman. Quite the best life of Harvey is from the pen of Mr. D'Arcy Power, F.S.A., F.R.C.S., in the "Masters of Medicine" series. To it I have been indebted for many facts. Although, therefore we have no complete contemporary biography of the greatest epoch-maker in medicine, we can glean enough to show us in what esteem he was held by certain very different kinds of persons. Hobbes, of Malmesbury, placed him alongside Copernicus, Galileo and Kepler, and declared "he first gave the true science of the human body." In another book Hobbes wrote of Harvey, as "the only man I know that, conquering envy, hath established a new doctrine in his life time."

The highly acute and ingenious natural philosopher Robert Hooke, F.R.S., mentions Harvey's discoveries alongside those of Pecquet, Bartholinus, Willis and Glisson. The great Descartes in one of his letters writes of Harvey, thus:

As to the circulation of the blood, *there* he has his triumph, and the honor of first discovering it, for which medicine owes him much.

Thomas Bartholinus, of Copenhagen, said:

The English physician to whom belongs the honor of having first shown that the course of the blood is nothing less than a kind of perpetual movement in a circle.

Elsewhere Bartholinus declared:

To have had the glory of discovering the movements of the heart and blood was enough for one man.

Haller, a very learned and discriminating authority, called the *De Motu*, "*libellus aureus*."

I must refrain from any references to allusions to Harvey in contemporary English verse: both Dryden and Cowley have lines on him, but they are very poor stuff indeed.

Nor have we to-night time to discuss the large question of the claims of the Italian naturalist, Cæsalpino, to the honor of the discovery, important as this undoubtedly is. Harvey's life and work is rather too large a topic for one evening hour, but perhaps enough has been said to let us have *some* idea of both.

The "*De Motu*" is the greatest single essay on a biological or medical subject ever given to the world. It ranks on an equality with those other epoch-making monographs of Jenner, Schwann, Darwin, Simpson, Pasteur and Lister. Harvey did for physiology what Newton did for astronomy: gave a generalization which put many isolated facts into their places. It revealed an astonishing unity of plan amid manifold diversities of type. So grand was the simplicity of the mechanism of the circulation that that alone was enough to tell him he had attained to a great truth. He saw the one design everywhere, in the heart of the chick as yet unhatched, in the humblest insect, in the stately deer in the Royal park at Windsor. Harvey's work was epoch-making, because he broke with tradition and because it was founded on an experimental basis. Although his name is not in the original charter-book of the Royal Society (it could not be as its date is 1664), all Harvey's intimate friends were Fellows, and there is no possible doubt but that Harvey *would* have been in the Royal Society, as he was in that earlier unorganized nucleus of it at Oxford. Though a professional anatomist, he studied structures to discover their uses. Just as one of Galen's books is the "*De usu partium*," so Harvey's masterpiece is "*Concerning the Motion and Uses of the Heart and Arteries*." Harvey is always physiologically-minded. Harvey was a great man in an age that produced many great men; he was not dwarfed by his contemporaries because they too were great. What Shakespeare and Molière are to the drama, what Milton is to poetry, Bacon to prose, Bunyan to allegory, Murillo and Rembrandt to painting, Wren to architecture, Grotius to international law and theology, Galileo and Newton to terrestrial and celestial physics (and these, all his contemporaries, are masters), such is William Harvey in the realm of the knowledge of the most important system in the bodies of living beings.